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2022 International Mind, Brain and Educations Society/EARLI SIG22 Conference

JULY 21–23, 2022

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MIND, BRAIN, AND EDUCATION

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OVERVIEW

Mind, Brain, and Education (MBE) provides a forum for the scholarly communication of basic and applied research on learning and development, including analyses from biology, neuroscience, cognitive science, and education.

The journal is part of the effort of the International Mind, Brain, and Education Society to be a scholarly source for the accurate translation of the science of biology, brain, and behavior into applications that will impact education efforts internationally and across ages and contexts. The journal also has a goal of stimulating collaboration across disciplines and between researchers and practitioners with different perspectives informing each other to advance the science of mind, brain and education. Thus, the journal has a goal of supporting the development of a framework for new ideas to advance research efforts at the intersection of biology, brain, cognition, and education, and the practical innovations these research efforts inform. The broad target audience is researchers who wish to report basic, high quality research as well as practice-based evaluation relevant to education.

AIMS AND SCOPE

Mind, Brain, and Education (MBE) publishes peer-reviewed articles addressing biological, brain, cognitive and behavioral questions that are relevant to the broad field of education. The journal operates through an open submission process. In addition, researchers are encouraged to contact the editorial board with ideas for reviews, commentaries and special issues. Short and full-length empirical reports, reviews and commentaries on specific topics broadly relevant to MBE readership, including to practitioners, will be considered.

MBE has an editorial board of internationally recognized scholars and practitioners from a variety of disciplines. MBE provides a forum for highest quality presentation of basic and applied research on learning and development across the ages, in typically developing and special needs populations, including analyses of biology, neuroscience, cognitive and social-emotional sciences, and education. Research in mind, brain, and education emphasizes the reciprocal relationship in which education informs biological and behavioral and cognitive research as much as these inform educational research and practice. MBE original research articles report novel discoveries from laboratory-based experiments or research in the settings of practice. MBE articles also may consider the biological, cultural and intergenerational factors that influence life-long learning and plasticity.

MBE strives to be a highly respected resource for reporting basic and translational data that provide a framework for developing a critical understanding of advancing educational practices and curricula. The journal is thus a venue for scientifically reliable, educationally relevant research that connects mind, brain and education, catalyzing the kinds of research across disciplines that are essential to promote research-based practices in education.

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Agenda

Thursday, July 21

TIME	EVENT	LOCATION
7:30 am–6:30 pm	Registration and Poster Setup	**Foyer**
9:00–10:00 am	Preconference – Writing Workshop with Annie Bookman-Byrne	**Concerto**
10:15–10:45 am	Preconference – Peer Mentorship Session	**Concerto**
11:00–11:30 am	Preconference – Pitch Talks	**Concerto**
11:45 am–12:45 pm	Preconference – Lunch with Leaders	**Concerto**
1:00-1:45 pm	Preconference Panel - Discussion on Educator Needs	**Concerto**
2:00–2:30 pm	Welcome, Conference Overview and MBE Update	**Opus 1/Opus 2**
2:30–4:00 pm	**SIG22 Keynote Address: Kou Murayama**	**Opus 1/Opus 2**
4:00–6:00 pm	Poster Session #1 and reception	**Foyer**
7:00 pm	IMBES Board Meeting and Dinner	
8:00–9:00 pm	Preconference – Networking Dessert	**Concerto**

Friday, July 22

TIME	EVENT	LOCATION
7:30–8:30 am	Registration, Breakfast and Poster Setup	**Foyer**
	EARLI Sig 22 Breakfast Meeting	**Tchaikovsky**
8:30–10:00 am	**Keynote Address: Elizabeth Bonawitz**	**Opus1/Opus 2**
10:00–10:30 am	Break	
10:30 am–12:30 pm	**The role of relational reasoning in mathematical and spatial thinking:** Implications for STEM education (pg. 8)	**Opus 1**
	Neuro-cognitive mechanisms of conceptual change in science and mathematics learning (pg. 8)	**Opus 2**
	Early Executive Functions Interventions and Educational Outcomes: Understanding successes and failures via a multilevel approach (pg. 9)	**Concerto**
	Equitable Education through Active Learning (pg. 10)	**Vivaldi**
	Mindset: Mechanisms, Relevance and Implementation (pg. 11)	**Tchaikovsky**
12:30–12:45 pm	Lunch Setup	**Opus1/Opus 2**
12:45–2:00 pm	LUNCH AND AWARDS PRESENTATIONS	**Opus1/Opus 2**
2:00–2:30 pm	Lunch takedown	**Opus1/Opus 2**
2:30–4:30 pm.	**Tools for Spatial Thinking:** Facilitating Learning and Engendering Spatial Habits of Mind (pg. 12)	**Opus 1**
	Neuroscience Research in Authentic Educational Contexts (pg. 12)	**Opus 2**
	The role of inhibitory control in math and science education (pg. 13)	**Concerto**
	Critical roles of emotions in students' learning, motivation, and development (pg. 14)	**Vivaldi**
	Executive functions in early childhood: Examining possibilities to foster child executive functions in educational settings (pg. 14)	**Tchaikovsky**
4:30–6:30 pm	Poster Session #2 and reception	**Foyer**

Saturday, July 23

TIME	EVENT	LOCATION
7:30–8:30 am	Breakfast	
8:30–10:00 am	**Keynote Address – Nathan Fox**	**Opus1/Opus 2**
10:00–10:30 am	Break	
10:30 am–12:30 pm	**UNESCO's International Scientific Evidence-Based Education Assessment (ISEEA):** towards a transdisciplinary research agenda and policy impact (pg. 16)	**Opus 1**
	Bridging educational practice and neuroscience to study developmental language disorders: a review of neuroimaging approaches (pg. 17)	**Opus 2**
	Understanding the Relation between EF and Math in Early Childhood: Insights from New Research and Perspectives (pg. 18)	**Concerto**
	Neuro/Cognitive Research to Inform Neurodiverse Education (pg. 18)	**Vivaldi**
	Developmental Perspectives: Digital Interventions and Mathematics Learning in Typical and Atypical Populations (pg. 19)	**Tchaikovsky**
12:30–2:00 pm	Lunch on own	
1:00–2:00 pm	**Impact of Digital Tools on Education Research** (pg. 32)	**Concerto**
	Applying the Science of Learning to Teacher Preparation (pg. 32)	**Vivaldi**
	Science Writing for a Wide Audience (pg. 33)	**Tchaikovsky**
2:00–3:30 pm	**Keynote Address – Susan Levine**	**Opus1/Opus 2**
3:45–4:45 pm	**Secondary teachers' neural activity when grading student work differs according to the social-cognitive complexity of their pedagogical orientation** (pg. 31)	**Opus1/Opus 2**
SIG22 Lightning Talks	**Exploring the longitudinal and cross-sectional relationships between white matter and reading skill** (pg. 31)	**Opus1/Opus 2**
	Effects of non-invasive brain stimulation on early memory consolidation in mathematics learning (pg. 31)	**Opus1/Opus 2**
	Relating Neural Mechanisms for Learning to Instructional Events in Online Learning Environments (pg. 31)	**Opus1/Opus 2**
4:45 pm	Poster Award Presentations and Closing Remarks	**Opus1/Opus 2**

KEYNOTES

SYMPOSIA

PANEL DISCUSSIONS

LIGHTNING TALKS

Keynote Speakers

Kou Murayama, PhD is a Professor for Educational Psychology at the Hector Research Institute of Education Sciences and Psychology. In 2020, he has been awarded with the prestigious Alexander von Humboldt Professorship. Kou Murayama's research focuses on a number of overlapping questions about how motivation works in human functioning. With his broad and interdisciplinary background both in basic and applied (especially educational) sciences, his research program features a "multimethod approach", combining a number of different perspectives, and methodologies (e.g., longitudinal modeling, behavioral experiments, neuroimaging, ecological momentary assessments, meta-analysis, educational intervention, computational/ statistical simulation) to gain a comprehensive understanding of motivation. One of the central themes of his recent work is to understand how humans are autonomously motivated to seek and gain knowledge (motivational state often called "interest" or "intrinsic motivation") and how we can apply this idea to educational settings.

Keynote Title: Curiosity and interest: Reward-learning framework of knowledge acquisition

Elizabeth Bonawitz is the David J. Vitale Associate Professor of Learning Sciences at Harvard University. Her work focuses on the basic science theories of learning with the broader goal of informing educational practice. Her research bridges two research traditions: cognitive development and computational modeling. Specifically, Bonawitz's empirical approach focuses on the structure of children's early causal beliefs, how evidence and prior beliefs interact to affect children's learning, the developmental processes that influence children's belief revision and curiosity, and the role of social factors (such as learning from others) in guiding learning. Bonawitz received her Ph.D. from MIT in the brain in cognitive sciences in 2009 working with Dr. Laura Schulz. She then completed a post-doctoral fellowship at University of California, Berkeley with Thomas Griffiths and Alison Gopnik (2009-2013). She was an Assistant and Associate professor of psychology at Rutgers University, Newark from 2013 until 2020 when she moved to Harvard. Bonawitz is the recipient of the James McDonnell Foundation Understanding Human Cognition Scholar Award and the Jacobs Early Career Research Fellowship. Her work is additionally currently funded by several NSF grants, the Caplan Foundation, and the Templeton Foundation. Her research has been published in top journals in psychology, cognitive science, and education. Additionally, she has served as Associate Editor for Cognitive Science (journal) and is on the governing board of the Cognitive Development Society and Children Helping Science.

Keynote Title: Developing Curious Minds: Computational, Neurological, and Behavioral Experiments of Children's Information Seeking for Learning

Nathan A. Fox is a Distinguished University Professor at the University of Maryland in the Department of Human Development and Quantitative Methodology. He has completed research on the biological bases of social and emotional behavior developing methods for assessing brain activity in infants and young children during tasks designed to elicit a range of emotions. His work on the temperamental antecedents of anxiety is funded by the National Institutes of Health where he was awarded a MERIT award for excellence of this research program. He is also a Principal Investigator on the Bucharest Early Intervention Project, a randomized trial to determine the efficacy of family care for infants with a history of abandonment and institutionalization. Dr. Fox is an elected a Fellow of the American Association for the Advancement of Science, the Association for Psychological Science and the American Academy of Arts and Sciences and received the Distinguished Scientific Contributions Award from the Society for Research in Child Development and the Distinguished Mentor Award and G. Stanley Hall Award for Lifelong Achievement in Developmental Science from Division 7 of the American Psychological Association. He is also the recipient in 2017 of the Ruane Award for Outstanding Research in Child and Adolescent Psychiatry and is a founding member of the National Scientific Council for the Developing Child where he is co-Scientific Director of this group.

Keynote title: Evidence to Impact: Translating Science to Policy

Susan C. Levine, PhD is the Rebecca Anne Boylan Distinguished Service Professor in Education and Society in the Departments of Psychology, Comparative Human Development, and the Committee on Education at the University of Chicago. She received her Bachelor of Science degree in Mathematics, Psychology and Education at Simmons College and a Ph.D. in Psychology at MIT. Her research examines the development of mathematical thinking, the relation of numerical and spatial thinking, and how variations in math learning experiences at home and at school affect this development. In another line of research, she studies the development of emotions and attitudes about math and their relation to math learning outcomes. Finally, she studies the potential of various kinds of interventions, including parent-child engagement with mathematical books, play activities, and technology, to enhance children's math learning. She served as a co-PI of the Spatial Intelligence and Learning Center, an NSF Science of Learning Center and is currently a member of the Development and Research in Early Math Education (DREME) network. She received the Ann L. Brown Award for Excellence in Developmental Research and is a Fellow of the American Academy of Arts and Sciences, the Association for Psychological Science, and the American Association for the Advancement of Science.

Keynote Title: Developmental Science and Early Math Learning: The Role of Research in Promoting Excellence and Equity

Symposia

Friday, July 22nd, 10:30 am–12:30 pm: Opus 1

The Role of Relational Reasoning in Mathematical and Spatial Thinking: Implications for STEM Education

Chair: **Jérôme Prado**, French National Center for Scientific Research & University of Lyon
Speakers: **Priya Kalra,**, Western University; **David Kraemer**, Dartmouth College; **Adam Green**, Georgetown University

Math and spatial skills are both fundamental to success in STEM fields. Although previous research has shown that those skills are strongly related to one another, the shared processes that account for their relationship remain largely unknown. One possibility is that math and spatial thinking are associated because both involve the ability to attend to and integrate relations between mental representations. This ability, termed relational reasoning, has been the focus of extensive research in cognitive psychology and neuroscience. However, few studies have examined how relational reasoning is associated with math and spatial thinking in STEM-relevant tasks and settings. This symposium will fill this gap by bringing together four researchers working in the fields of relational reasoning, mathematical cognition, and spatial cognition. The presentations will feature a unique combination of studies investigating relational reasoning in the lab and in real-world classrooms. Collectively, this research seeks to understand the degree to which relational reasoning is associated with math learning and spatial cognition, the neural mechanisms mediating this relationship, and whether relational reasoning may be improved by educational interventions targeting math or spatial thinking. The first speaker will focus on the role of relational reasoning in mathematical fraction reasoning and computation. She will explain why relational reasoning may be particularly relevant for fractions, and present behavioral evidence in support of this hypothesis. Finally, she will also attempt to situate the study of fractions within a broader space of relational reasoning, creating a link between numerical cognition and other research areas. The second speaker will describe neuroimaging work exploring the link between math learning and the processing of transitive relations (e.g., better than, smarter than) in elementary school children. He will notably show that impaired neural processing of transitive relations in the intra-parietal sulcus predicts math learning difficulties. The third speaker will present further neuroimaging data demonstrating that parietal activity during transitive reasoning reflects spatial processing in adults. This is in keeping with the long-standing idea that transitive reasoning relies on spatially represented mental models. Finally, the fourth speaker will describe a longitudinal study showing that a spatially-focused STEM curriculum leads to improved relational reasoning and increased recruitment of posterior parietal "spatial" regions during reasoning. These data indicate that relational reasoning abilities may be enhanced by improving spatial abilities. The presentations (20 minutes each, including 5 minutes for audience questions and responses) and subsequent discussion (approximately 20 min) will highlight how research in the lab and in real-world classrooms may contribute to a better understanding of the role of relational reasoning in math and spatial thinking. This symposium will also address the implications of these findings for interventions relevant to STEM education.

Friday, July 22, 10:30 am–12:30 pm: Opus 2

Neuro-Cognitive Mechanisms of Conceptual Change in Science and Mathematics Learning

Chair: **Roland Grabner**, University of Graz
Speakers: **Lorie-Marlène Brault Foisy**, Université du Québec à Montréal (UQAM); **Geneviève Allaire-Duquette**, Université du Québec à Montréal (UQAM); **Michaela A. Meier**, University of Graz

A large body of evidence has revealed that the acquisition of conceptual knowledge is a long-term process in which an intuitive or naïve theory about a phenomenon needs to be developed into a scientific concept (i.e., conceptual change). No consensus has yet been achieved about the neuro-cognitive

mechanisms underlying this long-term process. A growing number of studies support the notion that scientific concepts do not replace the learners' naïve theories but rather co-exist within long-term memory. This has been particularly demonstrated using a speeded-reasoning task in which participants are required to evaluate short statements about natural science phenomena. When the truth value of these statements differs between naïve and scientific theories (incongruent statements) performance is worse as compared to statements for which the truth value is consistent across the theories (congruent statements). This finding of a conceptual interference has been interpreted to reflect a cognitive conflict between the two co-existing theories, which needs to be resolved through the engagement of cognitive control mechanisms. Further support for this view comes from neuroimaging studies showing that especially inhibitory brain regions are involved in the evaluation of such statements. In this symposium, recent research on the neuro-cognitive mechanisms underlying conceptual change in science and mathematics learning is presented and discussed. In the first paper, Lorie-Marléne Brault Foisy provides an overview of the current evidence suggesting the involvement of inhibitory control processes in conceptual change. To this end, studies using different methodological approaches (behavioral and neuroscientific) and drawing on different science domains are reviewed. In the second contribution, Geneviève Allaire-Duquette presents the first neuroimaging study on the question of how persistent naïve theories are in science. Here, the brain activity of scientists with a PhD in physics is investigated while they assessed the scientific value of statements regarding naïve ideas in science. This study showed that even advanced science experts are burdened by the interference of naïve ideas. Finally, Michaela A. Meier reports on the first neuroimaging study on the interference between naïve and scientific theories in the domain of mathematics. By comparing samples of mathematicians with gender-, age-, and intelligence-matched non-mathematicians, this neuroimaging work revealed expertise-related individual differences in the behavioral and neurophysiological interference effects while participants evaluated congruent and incongruent mathematical statements. In all contributions, potential implications of the presented results for education are discussed as well as future directions of this research field.

Friday, July 22, 10:30 am–12:30 pm: Concerto

Early Executive Functions Interventions and Educational Outcomes: Understanding Successes and Failures Via a Multi-Level Approach

Chair: **Gaia Scerif**, University of Oxford
Speakers: **Sylvia Gattas,** University of Oxford; **Rosemary O'Connor,** University of Oxford; **Fionnuala O'Reilly,** Behavioural Insights Team; **Caylee Cook,** University of The Witwatersrand

A wealth of research has suggested robust correlations between executive function skills and early cognitive development, including emerging numerical cognition, language and literacy, but an understanding of these correlations remains elusive. Intervention studies offer the opportunity of testing causality. However, a number of recent executive functions interventions have failed to transfer to improvements in known correlated educational outcomes. This is problematic from theoretical and applied perspectives alike: if early execution functions training does not transfer reliably, should we forfeit it entirely? In the proposed symposium, we discuss the need to tackle explicitly the multiple levels at which interventions operate, if we aim to optimise transfer of executive functions improvements to educational outcomes: a. The child: individual differences in children's emerging attitudes and affect, that in turn guide attention and the executive in the context of early learning; b. Educators: individual differences in the learning environment provided by early years practitioners and steps towards optimising it via practitioner development; c. Parents: differences in opportunities in the home and how they may be tailored to scaffold learning; d. The socio-cultural environment: diverse environments in which young children come to deploy executive skills and learn. Sylvia Gattas will argue that children bring their attitudes and affect to how they direct attention and executive self-regulation when learning new skills, as for example in the context of emerging mathematical expertise. Understanding the emergence of these affective processes, and the dynamic role they play on guiding attention, and on being influenced by self-regulation is key. Rosemary O'Connor will move the emphasis from the child to the

Symposia

environment provided by supporting adults and peers in preschool. She will discuss steps needed to co-develop an acceptable, feasible and effective programme of practitioner development activities, geared to optimising the interplay between executive and mathematical skills in diverse preschools. Fionnuala O'Reilly will instead focus on parents as agents of change, by reporting on "Tips-by-text", a parent-delivered early years intervention developed in the United States, but trialled in a large scale randomised controlled trial in the United Kingdom, assessing improvements in early language, literacy and adaptive behaviours. Caylee Cook will close with an exploration of socio-cultural factors at play in the longitudinal interplay between executive skills and emerging numeracy, for children in low-income communities in South Africa. Specifically, as these pre-schoolers do not access early childhood education facilities, how do home learning opportunities and executive skills support emerging outcomes? Gaia Scerif (as Chair) will lead a discussion by returning to theories of change behind executive functions interventions: why should transfer of benefits to educational outcomes occur, when we improve children's executive skills? We will outline differential hypotheses about how domain-general, domain-specific and multi-level processes interact over early childhood.

Friday, July 22nd, 10:30 am–12:30 pm: Vivaldi

Equitable Education Through Active Learning

Chair: **Allyson Mackey**, University of Pennsylvania
Speakers: **Azzurra Ruggeri**, Max Planck Institute for Human Development; **Kat Adams Shannon**, Stanford University; **Igor Banscandziev**, Harvard Graduate School of Education

Curiosity is essential for learning. It not only motivates us to learn, but it guides our choices of what to learn and how to learn it. Indeed, curiosity predicts math and reading gains in kindergarten, and this is especially true for children from lower socioeconomic backgrounds. Understanding how children's early experiences shape cognitive and neural systems that support curiosity is crucial for developing tools and learning environments that support children's learning, in classroom settings and beyond. In this symposium, we will present multidisciplinary perspectives on the development of curiosity, discussing implications for equitable instructional approaches and curriculum design.

Prof. Dr. Dr. Azzurra Ruggeri (MPRG iSearch, Max Planck Institute for Human Development in Berlin, Germany; Technical University Munich, Germany; Central European University, Vienna, Austria) will present data on novel tablet-based measures of curiosity and active learning collected in Egypt, Cuba, and Germany. Across all cultural contexts, she finds no evidence of associations between socioeconomic status and curiosity, suggesting that children from lower SES backgrounds have the same information-seeking skills as their peers with more resources.

Kat Adams Shannon, Ph.D., is an applied developmental psychologist and postdoctoral scholar at Stanford University. She will present data investigating how preschoolers vary in how well they learn by actively selecting or passively receiving information. Do all young children show an active advantage, or do some benefit by learning passively? If so, what kinds of passive observations support learning? And what skills support success in either approach? She will discuss the role of executive function as a key moderator of active and passive learning outcomes, highlight the importance of matching degree of informational control to individual needs, and explore the generalizability of results across preschool sites that serve children from diverse SES backgrounds.

Allyson Mackey, Ph.D., is a developmental cognitive neuroscientist and Assistant Professor at the University of Pennsylvania. She will present data from an experiment showing that children learn better when they are encouraged to ask questions, as compared to when they are told to listen carefully, and that benefits are larger for children with higher stress exposure and lower executive function. She will also discuss how neural systems for curiosity, including dopamine synthesis in the ventral tegmental area, promote learning, and are shaped by early experience.

Igor Banscandziev, Ph.D., Postdoctoral Fellow in the Harvard Graduate School of Education, will discuss an educational intervention that may benefit lower-resourced schools and that engages 6- to 8-yr-old children's learning of science content and engagement through a novel "thought-experiment" intervention.

Taken together, these findings suggest that children from lower SES backgrounds may benefit from learning contexts in which they are encouraged to seek information and that scaffolding may be important to support the development of these active learning skills. We will discuss whether curiosity ought to be an explicit target of classroom instruction, and whether we have the measurement tools to support such a goal. We will close by inviting the audience to brainstorm how we can design educational contexts that promote, rather than extinguish, children's exploration.

Friday, July 22, 10:30 am–12:30 pm: Tchaikovsky

Mindset: Mechanisms, Relevance and Implementation

Chair: **Nienke van Atteveldt**, Vrije Universiteit Amsterdam
Speakers: **Elizabeth Tricomi**, Rutgers University-Newark; **Tieme Janssen**, Vrije Universiteit; **Junlin Yu**, University of Helsinki; **Bert De Smedt**, KU Leuven

Differences in children's cognitive abilities are partly caused by biological mechanisms, such as genetics. However, children with comparable ability levels can still show different school trajectories, which emphasizes the role of non-cognitive factors such as motivation and self-beliefs. A non-cognitive factor that received a lot of interest from researchers and education professionals, is a child's implicit belief of intelligence, or mindset. Research suggests that when children (implicitly) believe that their abilities can improve by their own efforts (incremental mindset), they are more resilient to setbacks, more motivated, and yield higher learning achievements compared to children who view their abilities as fixed and out of their own control (entity mindset). However, there is increasing criticism on the validity and practical relevance of mindsets. Several studies failed to replicate effects and meta-analyses show absent or weak effects of mindset interventions. Moreover, anecdotal messages (e.g., blogs) report about incorrect implementation of 'mindset thinking' in schools. This symposium brings together researchers studying the topic of mindset at different levels, from neuroscience to practice-based research, and aims to discuss the mechanism and relevance of incremental mindset for learning and motivation. A thorough and critical discussion on the merits and limitations of mindset will be led by prof. Bert De Smedt. The first speaker, Dr. Elizabeth Tricomi, will discuss the neural mechanisms underlying mindset-related differences in learning. She will present fMRI research investigating how the neural response to feedback indicating an incorrect response differs depending on whether subjects interpret the feedback as evaluative or informative. She will highlight a study that found that when competence was threatened, participants with entity mindsets interpreted further negative feedback as punishing. These participants showed poorer learning from negative feedback when the evaluative weight of feedback was emphasized and an inflexible striatal response to negative feedback across different feedback contexts. The second speaker, Dr. Tieme Janssen, will present recent evidence showing that the relation between mindset, goal-orientation and motivation is more complex than the simple dichotomy 'incremental versus entity mindset'. After a brief literature overview and rationale, he presents three studies in which Latent Class Analysis was used to identify new subgroups of adolescents, focusing on: (1) motivational profiles based on a wide range of self-reported motivational constructs, and (2) how a growth mindset intervention affected these motivational profiles, and (3) effort profiles, based on different choice patterns during a math effort task. In light of these findings, he will discuss future research avenues to embrace the more complex and nuanced reality of mindset. The third speaker, Dr. Junlin Yu, will discuss teacher and school factors that communicate mindset messages to students. He will present a study that examined the associations of student mindsets with various dimensions of teacher beliefs, teaching practices, and school climate. Multilevel analyses show that students had a stronger growth mindset in classrooms where teachers used guided inquiry and in schools that valued students' social-emotional development. In contrast, students had a stronger fixed mindset when teachers differentiated tasks by ability.

Symposia

Friday, July 22nd, 2:30– 4:30 pm: Opus 1

Tools for Spatial Thinking: Facilitating Learning and Engendering Spatial Habits of Mind

Chair: David Uttal, Northwestern University
Speakers: Naomi Polinsky, Northwestern University; **Yanning Yu**, Northwestern University; **Jose Sotelo**, Northwestern University; **Kinnari Atit**, University of California, Riverside

Spatial thinking refers to thinking about the locations of objects, the relations among those objects, and transformations of those relations (Kastens & Ishikawa, 2006). It plays an essential role in education because many concepts students learn and problems they solve benefit from visualizing, mentally rotating, and noticing patterns (Newcombe & Frick, 2010). Although challenging, spatial thinking can be facilitated through the use of visualizations and spatial games (Newcombe, 2017; Wu & Rau, 2019). This symposium examines if and how the use of visual displays or games can enhance spatial thinking. Spatial thinking tools are often intended to achieve two goals. The first is to facilitate spatial thinking in the moment by providing a manipulative for problem solving, for conceptualizing new information, and for practicing spatial visualization. The second is to engender longer-term spatial habits of mind, the inclination to engage in spatial reasoning and representation to solve and understand problems (Feng et al., 2007; Kim & Bednarz, 2013). We will discuss both goals across the symposia. Naomi Polinsky will discuss children's use of a touchscreen game similar to a tangrams puzzle. She will describe the unique affordances of the app for promoting spatial thinking: Children must recreate a sample picture using corresponding shapes and also place the recreated picture in a location that matches the location of the sample picture on the other side of the screen, a task that is exclusive to digital technology. Her presentation will focus on data describing the ways in which playing with the app may promote spatial habits of mind by challenging children in their zones of proximal development and pushing them to engage in spatial visualization and relational thinking. Yanning Yu will focus on the Chinese game of GO. This game requires substantial spatial reasoning, and the talk will present the results of three studies with 7- and 8-year-olds that demonstrates ways in which playing GO can enhance spatial thinking. GO facilitates in-the-moment spatial processing by allowing children to create and recognize spatial patterns, which are crucial for learning to play GO. GO can also promote longer-term spatial reasoning by encouraging children to compare multiple solutions and take on the opponent's perspective. Jose Sotelo will present data on using a Geographic Information System (GIS) infused curricula in Chicago public schools to promote spatial thinking. GIS organizes data into visualizations, to reveal spatial patterns and relationships. Engagement with GIS allows students to answer questions, and provides them with the skills to conceptualize problems spatially. Finally, Dr. Kinnari Atit will present on the efficacy of using online simulations to teach spatial chemistry, stereochemistry, content to undergraduate organic chemistry students. While stereochemistry is typically taught using hands-on activities, simulations are relevant for student learning in online courses. She will discuss data comparing students' learning of the spatial content from handheld models and simulations, and on how these spatial tools differentially enhance students' understanding of novel spatial concepts within the chemistry domain. Finally, Dr. David Uttal will integrate the findings in a Discussion.

Friday, July 22, 2:30– 4:30 pm: Opus 2

Neuroscience Research in Authentic Educational Contexts

Chair: Ido Davidesco, University of Connecticut
Speakers: Jennie Grammer, University of Virginia; **Julien Mercier**, Université du Québec à Montréal; **Nienke van Atteveldt**, Vrije Universiteit Amsterdam; **Bruce McCandliss,** Stanford University

Cognitive neuroscience research is typically conducted in controlled laboratory environments that bear little resemblance to real-world learning settings. This symposium will highlight recent efforts to increase the ecological validity of neuroscience research by using

more naturalistic stimuli and tasks and by conducting research in authentic educational contexts with the use of portable Electroencephalography (EEG). Five presentations by a diverse group of speakers will be followed by a discussion on the opportunities and challenges afforded by this emerging line of research. Jennie Grammer (University of Virginia) will discuss the use of portable EEG to examine children's attentional processes in early elementary school classrooms. Specifically, she will share EEG data related to children's attention during different types of classroom activities (e.g., whole group instruction, individual seat work, group work), and discuss the implications of this work for developing instructional settings that support the development of attentional skills. Julien Mercier (Université du Québec à Montréal) will discuss the use of EEG, eye-tracking, and other measures in authentic learning tasks. He will present recent advances in modeling affect and cognition in dyads of learners. He will also describe current issues and potential solutions in causally linking this moment-by-moment, fine-grained record of affective and cognitive processes with learning gains. Nienke van Atteveldt (Vrije Universiteit Amsterdam) will discuss how portable EEG can be integrated in lessons or interventions to teach children about the brain and their own influence on their learning processes. She will present results of an intervention for young adolescents in which EEG-based neurofeedback was integrated within a growth mindset intervention to increase students' sense of agency and related motivation profiles including mindset. Ido Davidesco (University of Connecticut) will describe how portable EEG technology can be used to simultaneously measure the brain activity of a group of students in a classroom. This research suggests that students and teachers exhibit similar brain activity patterns (a phenomenon called "Brain-to-Brain Synchrony"), and that the extent of brain synchrony is predictive of learning outcomes. Bruce McCandliss (Stanford University) will describe a partnership with innovative K-8 schools that integrated EEG laboratories into their schools to encourage interactive learning about one's own developing brain, changes in brain state induced by mindfulness practices, and a school-wide research partnership to explore how learning experiences give rise to perceptual expertise in reading. This research project explores how steady state visual evoked potentials may provide advantages for studying representational change within children over time.

Friday, July 22, 2:30– 4:30 pm: Concerto

The Role of Inhibitory Control in Math and Science Education

Chair: Gregoire Borst, Université de Paris
Speakers: Lorie-Marlene Brault-Foisy, Université du Quebec à Montréal; **Genevieve Allaire-Duquette**, Université de Sherbrooke; **Iroise Dumontheil**, Birkbeck University of London; **Reuven Babai**, Tel Aviv University

In mathematics and science students often hold a variety of intuitive conceptions about various phenomena, most often referred to as misconceptions. These misconceptions are not consistent with scientific knowledge or logico-mathematical reasoning and therefore interfere with learning. Interestingly these misconceptions often persist even after students have received formal instruction in science or mathematics. The aim of the symposium is to discuss the role of Inhibitory control (i.e., the ability to resist automatisms, temptations, distractions, or interference and to adapt to conflicting situations) in reasoning in science and mathematics. Assistant Professor L-M. Brault-Foisy from the department of education science of UQAM (Canada) will present converging evidence from studies relying on behavioral and neuroimaging methods that inhibitory control over various misconceptions is critical to acquire scientific concepts in physics and biology and she will discuss the implications of these findings for STEM education. G. Allaire-Duquette a postdoctoral educational researcher at Université de Sherbrooke (Canada) and Reuven Babai, senior lecturer at Tel Aviv University (Israel) will discuss to what extent inhibitory control intervention in the classroom or lab settings have the potential to improve reasoning in science and mathematics. In particular she will present data showing that an inhibitory control intervention improves reasoning in math in 6th graders, but not in adults. Iroise Dumontheil a Professor in Cognitive Neuroscience at Birkbeck University of London (England) will present the results of results of a large randomized control trial which evaluated the impact of Stop and Think, an intervention which aimed to encourage children to inhibit incorrect intuitive response and instead spend more time reasoning, in math and science in more than 6,000 primary school children. Finally, Professor G. Borst from the Psychology department of Université de Paris (France) will present

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the results of a series of online participatory science studies conducted with teachers in pre-schools and primary schools aiming at helping students overcome systematic difficulties in resolving arithmetic word problems by improving inhibitory control over misleading strategies constructed in previous year of schooling. He will discuss more generally how such online participatory science projects can be effective in bridging the gap between the lab and the classroom and improve science literacy of teachers.

Friday, July 22, 2:30– 4:30 pm: Vivaldi

Critical Roles of Emotions in Students' Learning, Motivation, and Development

Chair: **Michiko Sakaki**, University of Tübingen
Co-Chair: **Kou Murayama**, University of Tübingen
Speakers: **Garvin Brod,** DIPF|Leibniz Institute for Research and Information in Education; **Mary Helen Immordino-Yang**, University of Southern California; **Suzanne Hidi**, University of Toronto

Classrooms are full of emotions. Students sometimes enjoy learning new topics, get surprised and curious when they face unexpected outcomes, are frustrated when their learning does not go well, and experience both positive and negative emotions from feedback they receive. Students' emotions in classrooms are also affected by their interactions with their teachers, friends and parents. Despite their clear relevance, until recently, the roles of emotions have received relatively little attention in education research except for a few specific emotions (i.e., anxiety). In addition, many of the previous studies on emotion in education have relied on cross-sectional data; these findings have provided important insights and implications for educational practice, but there is a definite need for more research to understand the within-person effects of emotion with interdisciplinary and multi-method perspectives. The current symposium puts together prominent researchers who conduct research on emotion in education from a variety of theoretical perspectives (appraisal theory, valence-arousal model, epistemic emotion, and socio-cultural emotion) and methodologies (e.g., neuroimaging, pupillometry), with the aim to have lively and interdisciplinary discussions on how emotions influence/are influenced by learning, motivation, and the development of students. Michiko Sakaki will discuss the role of appraisal in achievement emotions, while highlighting the importance of valence and arousal in determining consequences of emotions on learning and relevant cognitive processing. Garvin Brod will discuss the role of surprise in children's conceptual change, showing that children's pupillary surprise response when seeing information that contradicted their naïve theory predicted successful theory revision. Mary-Helen Immordino Yang will present longitudinal psychosocial and neuroimaging data on the role of adolescents' social-emotional narratives in supporting their relationships, brain development, and ego integrity in young adulthood. Suzanne Hidi will discuss the relations between interest and emotion based on her four-phase model of interest development and emphasize how neuroscientific findings contribute to our understanding of interest development.

Friday July 22, 2:30– 4:30 pm: Tchaikovsky

Executive Functions in Early Childhood: Examining Possibilities to Foster Child Executive Functions in Educational Settings

Chair: **Janina Eberhart**, University of Tübingen
Speakers: **Tanya M. Paes**, Purdue University; **Regula Neuenschwander,** University of Bern; **Andrei Semenov,** University of Minnesota

Executive functions, higher-order cognitive skills, are crucially important for children's success in school and life (Diamond et al., 2007; Robson et al., 2020). Many researchers aim to understand how executive functions can be enhanced (Takacs & Kassai, 2019). A way to reach many children is through educational settings such as pre- or elementary school. Scholars have argued that creating environments that allow executive function skills to develop may be more important

and effective than practicing executive functions per se (Mattera et al., 2021). Furthermore, the task of improving executive function skills requires effort from both caregivers and educators. Various aspects related to creating conducive school and home environments can be explored. This symposium includes preschool and elementary school children from three different countries (USA, UK, Switzerland) and aims to highlight different targets for intervention by which executive functions might be enhanced. Our classroom variables of interest concern social interactions in the classroom, organizational aspects such as children's daily schedule as well as activities that provide children an opportunity to practice turning inwards and volitionally guiding their thoughts. Our variables within the family include autonomy-supportive parenting practices and mindfulness. Our contributions aim to bridge the gap between cognitive neuroscience and education by relating aspects of children's daily classroom and/or home experiences to their executive function development. Paper 1 examines the role of teacher-child closeness and conflict in US-preschoolers and the association with children's problem behavior, their social skills and executive functions cross-sectionally. Parental education is explored as a potential moderator in this relationship. Paper 2 investigates the proportion of time that UK-preschoolers spend in teacher-led and child-led activities in classrooms and their association with executive function development assessed longitudinally with direct assessments and observational measures. Paper 3 tests the effects of a mindfulness-based curriculum on children's executive functions in Swiss elementary school classrooms. Furthermore, the question of how executive functions (direct assessments, parent and teacher reports) and mindfulness (behavioral assessments) relate to each other in young children will be explored. Paper 4 reports on the results of a US-based parent education program called Ready4Routines. This program promotes autonomy supportive parenting practices, parent mindfulness and the scaffolding of executive function skills within the context of daily family routines. The implications of autonomy supportive practices on children's executive function development is discussed. All papers will highlight the expected underlying mechanisms for the assumed changes in children's executive functions and present these in a Theory of Change model (i.e., the connection between the input, psychological mechanisms, and the output). Findings will be discussed in terms of (a) relevance for educational contexts and (b) possible translations into interventions in educational settings.

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Saturday, July 23, 10:30 am–12:30 pm: Opus 1

UNESCO's International Scientific Evidence-Based Education Assessment (ISEEA): Towards a Transdisciplinary Research Agenda and Policy Impact

Chair: **Marieke Buil**, Rotterdam University of Applied Sciences
Speakers: **Anantha Duraiappah,** UNESCO - Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP); **Nandini Chatterjee Singh,** UNESCO - Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP); **Kenneth Pugh**, Yale University; **Latika Gupta**, Delhi University; **Grégoire Borst**, University Paris Descartes; **Julien Mercier**, University of Quebec in Montreal; **Nienke van Atteveldt**, Vrije Universiteit Amsterdam; **Rémi Quirion**, First Chief Scientist of Quebec; **Jean-François Roberge**, Education minister of Quebec

Today's societies face different challenges from those of 300 years ago, when systems of mass schooling developed. Climate change, uncertain job markets, growing social inequality, and pandemics such as the ongoing Covid-19, are the challenges we currently face. Two urgent questions are therefore: Are education systems still serving the right purpose? More specifically, is a focus on training a workforce for promoting economic growth the right aim, or should improving human flourishing be more central, for building a more peaceful and sustainable future? Are education systems equipped to address the pressing challenges we face today? To answer this, we need to take stock of the current state of knowledge on education and learning. The International Scientific Evidence-Based Education Assessment (ISEEA) was initiated in 2019 by UNESCO MGIEP to answer these questions, and its background and approach will be introduced by the 1st speaker (Anantha Duraiappah). The ISEEA is a systematic assessment of the existing knowledge on education and learning drawing from a multitude of disciplines encompassing the entire complexity of learning and education: goals of current education systems and their relevance to today's societal needs (presented by Nandini Chatterjee Singh), the broad sociopolitical contexts in which education is embedded (presented by Ken Pugh and Latika Gupta), and the state of the art in learning process drawn from the mind, brain and education (MBE) fields of research (presented by Grégoire Borst). In addition, we have assessed what evidence actually means and how data can and should be used in educational policymaking and practice (presented by Julien Mercier). While other reviews and reports have addressed pieces of this complex education ecosystem, the ISEEA is the first to start from an integrated conceptual framework, to bring all the streams of knowledge together to answer the two overarching questions mentioned above. Two main outputs of the ISEEA are 1) the full report, comprising 25 chapters authored by ~260 scientists from a wide range of disciplines and countries; and 2) the Summary for Decision Makers (SDM), a synthesis of the full report in which we draw from all chapters to answer the overarching questions, which require a novel integration of all the perspectives to be answered (presented by Nienke van Atteveldt). Multidisciplinarity has been essential to the ISEEA in pursuing the ultimate goal of providing policy-relevant recommendations to reimagine education for the future. A huge challenge in education research is how to gain policy impact when appropriate. The discussion in this symposium is therefore devoted to the science-policy interface, where several leading education policymakers (Rémi Quirion, First Chief Scientist of Quebec and Jean-François Roberge, Education minister of Quebec (tbc)) and reflect on the ISEEA findings and discuss what steps need to be taken for the proper research findings to reach policy impact. The discussion is open for all MBE researchers who would like to discuss how to make their research pertinent, visible and usable for policymakers.

Saturday, July 23, 10:30 am–12:30 pm: Opus 2

Bridging Educational Practice and Neuroscience to Study Developmental Language Disorders: A Review of Neuroimaging Approaches

Chair: **Ola Ozernov-Palchik**, MIT
Speakers: **Nicole Landi**, University of Connecticut; **Tracy Centanni**, TCU; **Kaja Jasinska**, University of Toronto; **Dan Kleinman**, Yale University

In recent years, noninvasive neuroimaging has provided remarkable new insights into the neural underpinnings of developmental language disorders. Such discoveries were made possible through constructive collaborations among neuroscientists, practitioners, and families. Additionally, emergent technologies for imaging the human brain have allowed researchers to optimize the ecological validity of such studies, with different methods having different strengths and limitations for conducting research at the intersection of neuroscience and education. In this presentation we will review four different neuroimaging methods for studying developmental language disorders in the context of four unique case studies of successful of school-lab partnerships. 1) Dr. Ola Ozernov-Palchik (MIT, Harvard) will present results from an fMRI study of language comprehension in 2nd-4th grade children with and without dyslexia. The study investigated the neural underpinnings of the decoding and listening comprehension components of reading comprehension using a word-level semantic and phonological judgment task and a narrative comprehension task. The study was conducted in partnership with an independent school for children with specific learning difficulties. Results indicate that the two constructs were associated with both overlapping and distinct neural systems. Implications for the assessment and remediation of reading comprehension deficits are discussed. 2) Dr. Tracy Centanni (TCU) and Dr. Dan Kleinman (Yale University) will present results from a MEG study of children with dyslexia. Children were passively exposed to speech and non-speech stimuli while in the MEG. Approximately half of the children with dyslexia exhibited decreased neural consistency to repeated stimuli. Interestingly, this neural inconsistency was not related to sensitivity in the visual word form area. These findings suggest that neural inconsistency and VWFA hypoactivation are separate neural deficits in dyslexia and highlight the heterogeneity in the population. 3) Dr. Kaja Jasinska (UToronto, Haskins) will present results from an fNIRS study of children developing in environments with high-risk of illiteracy, rural Côte d'Ivoire. 5th graders with poor literacy skills participated in an fNIRS neuroimaging study examining patterns of neural activation for spoken language and reading. Results indicate robust left hemisphere engagement of the IFG and STG for stronger readers and poor sensitivity to lexicality among the poorest readers, with patterns of neural activation unlike those of children with reading disorders or younger children with low reading skills. Results are discussed in terms of sensitivity periods for the acquisition of reading. 4) Dr. Nicole Landi (UConn, Haskins) will present results from an in-school neuroscience study of children with treatment resistant reading difficulties who are undergoing intensive reading intervention. Children were tracked longitudinally with frequent EEG and neurocognitive assessment to establish predictors of reading intervention response. Results from children (ages 8.0 - 16.0) suggest that reading skill is associated with several EEG/ERP indices of print and speech processing (N170, N400) at multiple time points, but no strong predictors of intervention response were identified in this sample. Discussion will focus on the promise of in-school neuroscience models, which have high ecological validity, for establishing sensitive markers of reading outcomes, as well as study limitations (e.g., covid associated attrition).

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Saturday, July 23, 10:30 am–12:30 pm: Concerto

Understanding the Relation Between EF and Math in Early Childhood: Insights from New Research and Perspectives

Chair: Andrew Ribner, University of Pittsburgh
Speakers: Eric Wilkey, Vanderbilt University; **Dana Miller-Cotto**, Kent State University; **Caylee Cook**, University of Witwatersrand
Rebecca Merkley, Carleton University

Recently, the construct of executive functioning (EF; cognitive processes that allow for the volitional control of one's attentional and behavioral resources) has become central to both theoretical and applied discussions surrounding young children's academic achievement, particularly in terms of how it relates to math development. Both EF and math are strong indicators of school readiness and appear to be tightly linked across the early childhood years. However, not much is currently known about the specific mechanisms underlying this relation. Developing a more nuanced understanding of the relation between EF and math in early childhood can ultimately inform efforts that aim to support the co-development of both skills in order to boost school readiness and subsequent achievement. Overall, the proposed symposium brings together novel research on the relation between EF and math in early childhood with the aim of further elucidating the nature of this relation and ultimately informing both theory and educational practice. This symposium will consist of four talks that each explore the relation between early EF and math from different perspectives and levels-of-analysis. First, Dr. Eric Wilkey will present findings from three studies that investigate the unique contributions of both domain-general (i.e. IC) and domain-specific (i.e. number processing) predictors of math achievement. Specifically, Dr. Wilkey will present evidence from both behavioral and neural levels-of-analysis suggesting that attentional components of the number comparison task predict math achievement beyond either domain-general or domain-specific factors alone. Next, Dr. Dana Miller-Cotto will use longitudinal data to test three theoretical models concerning the co-development of WM and both skills for children with math learning difficulties in order to determine whether model fit differs based on established theories. Following this, Dr. Caylee Cook will present findings from a study of young South African children from very low-income settings who did not have access to early childhood education. Correlations between executive functions and numeracy skills were found in this sample, yet the experiences of these children differ from those who are typically included in cognitive science research. Dr. Andrew Ribner will then take into consideration the fact that different methods of statistical modeling reveal different patterns of relations between EF and math. Specifically, Dr. Ribner will use large-scale longitudinal data to examine different ways of modeling the unidirectional and bidirectional relations, as well as parallel growth processes, between EF and math. He will discuss how implications for theory and practice may differ according to the theoretical model in question. To conclude, Dr. Rebecca Merkley will lead a discussion on how the findings come together to inform theories of EF and math development in addition to the implications for early childhood education. Future directions for research in this area will also be discussed.

Saturday, July 23, 10:30 am–12:30 pm: Vivaldi

Neuro/Cognitive Research to Inform Neurodiverse Education

Chair: Ibrahim Dahlstrom-Hakki, TERC
Speakers: Joanna Christodoulou, MGH Institute of Health Professions; **Rachel Romeo**, University of Maryland College Park; **Sidney D'Mello**, University of Colorado Boulder; **Jodi Asbell-Clarke**, TERC; **Zachary Alstad**, TERC

Traditionally, education's primary response to students struggling with learning has been dosage. This often takes the form of longer or more frequent sessions delivering the same content using the same approach. For example, the primary accommodation in test taking for individuals with disabilities is extended time regardless of diagnosis (Lovett, 2010). While can be helpful, many neurodiverse learners may require a different approach. Advances in understanding

how neurodiverse brains process information are informing new approaches to supporting the learning of neurodiverse learners. This symposium will feature a panel of experts from the Neuro, Cognitive, and Learning sciences who will share their own scholarship and advances in their respective fields and how those might shape more effective approaches to teaching and supporting the learning of neurodiverse individuals. The session will be chaired and moderated by Ibrahim Dahlstrom-Hakki Ph.D. Dr. Dahlstrom-Hakki is a cognitive psychologist whose work focuses on effective methods to teach and support neurodiverse learners in STEM. The panel will include Jodi Asbell-Clarke, Ph.D., a learning scientist who works on interventions for students with executive function difficulties and is currently authoring a book on how the neuro and cognitive sciences are shaping educational interventions, Zachary Alstad, Ph.D., a neurodiverse educational researcher will share his own work and the value of including neurodiverse voices in all levels of research, Sidney D'Mello, Ph.D., a cognitive scientist whose work on affective and cognitive states can help shape future interventions for neurodiverse learners, Rachel Romeo, Ph.D., CCC-SLP, a developmental cognitive neuroscientist and speech-language pathologist investigating the causes and consequences of individual differences in typical and atypical language and literacy development, and Joanna Christodoulou, Ed.D., a developmental cognitive neuroscientist who studies the brain-behavior links underlying reading development and difficulties, and their link to academic skills including math and attention. The session will begin with an introduction by Dr. Dahlstrom-Hakki followed by 15-min presentations on the following topics: - Dr. Christodoulou will discuss the neurocognitive basis of dyslexia as it relates to executive function and ADHD and implications for assessment and intervention. - Dr. Romeo will discuss the growing body of research, including her own, that finds certain neurocognitive foundations of learning and learning disabilities are moderated by children's early environments, and how this informs targeted interventions. - Dr. D'Mello will discuss the development of intelligent interventions that target particular mental states (confusion, mind wandering, etc) and how this work can be applied/adapted for neurodiverse learners. - Dr. Alstad will provide the perspective of a researcher in the field of neurodiversity who is also diagnosed with ADHD and dyslexia and will speak to project work using co-design and the "nothing about us without us" ethos. - Dr. Asbell-Clarke will provide a rationale for treating neurodiversity as a potential asset to STEM learning, and the types of pedagogies that can help neurodiverse learners thrive. This will be followed by a 45-minute Q&A session/discussion moderated by Dr. Dahlstrom-Hakki with questions from the audience as well as some pre-prepared question from the moderator.

Saturday, July 23, 10:30 am–12:30 pm: Tchaikovsky

Developmental Perspectives: Digital Interventions and Mathematics Learning in Typical and Atypical Populations

Chair: **Parnika Bhatia,** Lyon Neuroscience Research Center (CRNL)
Speakers: **Daniel C.Hyde**, University of Illinois at Urbana-Champaign; **Allison Liu**, Worcester Polytechnic Institute; **Francesco Sella**, Loughborough University; **Jérôme Prado**, Lyon Neuroscience Research Center (CRNL); **Kirk Vanacore**, Worcester Polytechnic Institute

Numeracy is an essential skill for later life outcomes such as physical and mental well-being and employment opportunities. Yet, for most, mathematical competency is hard to acquire. Specifically, complex concepts like fractions and algebra are difficult to teach and learn. Moreover, even elementary-level mathematics can be a challenge for atypical populations. To this end, digital interventions could serve as support tools for teachers in classroom instruction and aid in scaffolded learning for individual students. In this symposium, we bring together experts working with digital interventions to help improve mathematical learning outcomes. The talks will feature age-specific digital tools for mathematics learning in both typical populations as well as children with Down Syndrome. Importantly, this symposium will address three major questions. First, what is the role of game-based interventions in enhancing mathematical learning outcomes? Second, how can

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in-game metrics guide educators and researchers to move towards individualization in the classroom? Lastly, how can digital interventions support mathematical learning in children with disabilities and disorders, particularly children with Down Syndrome (DS)? In the symposium, the first speaker will present a novel experimental training method to help investigate the role of symbols in the development of numeracy in preschool-aged children in the U.S. and Italy (N = 215). The talk will present evidence for the importance of the introduction of symbols to preschoolers, specifically by enhancing the capacity for thinking about one-to-one correspondence and arithmetic transformation. The second speaker will then present a pre-registered, randomized controlled study examining a game for fraction learning for 5th-grade students (N = 188). This talk will discuss the potential role of teachers as well as in-game metrics for fraction learning in the classroom. Moving towards analyzing in-game metrics for improving learning outcomes, the third speaker will explore how error- and reward-based feedback systems relate to two persistence learning behaviors—resetting problem-solving steps and replaying completed problems—and student outcomes in From Here to There! (FH2T), a game-based learning environment that teaches algebra to 7th-grade students (N= 1,031). The findings of this study will have implications for game design elements that may improve learning and engagement. The last speaker will discuss the efficacy of the adaptive (non-commercial) computerized game "The Number Race" in improving specific numerical skills in children with DS. The talk will also focus on how parents can utilize this intervention for children with DS. The presentations (20 minutes each, including 5 minutes for audience questions and responses) and subsequent discussion (approximately 20 min) will highlight the importance of digital interventions as "support tools" for teachers to enhance mathematics learning outcomes. It will also help researchers to think about novel ways to utilize feedback/ in-game metrics data to help design effective digital interventions. Importantly, the symposium will be a space for brainstorming ideas to utilize digital interventions to aid in inclusive education practices that support quality education for all students.

Posters

Thursday, July 21

1. THE EFFECT OF EXPOSURE TO THE COVID-19 PANDEMIC ON INFANT DEVELOPMENT AND MATERNAL MENTAL HEALTH

Jessica F. Sperber, Teachers College, Columbia University; **Emma R. Hart,** Teachers College, Columbia University; **Sonya V. Troller-Renfree,** Teachers College, Columbia University; **Tyler W. Watts,** Teachers College, Columbia University; **Kimberly G. Noble,** Teachers College, Columbia University

2. WHY ARE SOME INDIVIDUALS BETTER GESTURERS? MULTIPLE COGNITIVE FACTORS INFLUENCE PERFORMANCE

Bradley E. White, Gallaudet University; **Cryss Padilla,** Gallaudet University; **Grady Gallagher,** Gallaudet University; **Joseph Palagano,** Gallaudet University; **Charles Harris,** Gallaudet University; **Laura-Ann Petitto,** Gallaudet University

3. ELECTROPHYSIO-LOGICAL CORRELATES OF NUMERICAL ORDER PROCESSING AND THEIR ASSOCIATION TO ARITHMETIC

Stephan E. Vogel, University of Graz; **Clemens Brunner,** University of Graz; **Nele Schröder,** University of Graz; **Philip Schadenbauer,** University of Graz; **Roland H. Grabner,** University of Graz

4. ACHIEVEMENT EMOTIONS IN THE COMMUNITY OF INQUIRY FRAMEWORK: HOW ACTIVITY EMOTIONS IMPACT ACADEMIC ACHIEVEMENT

David Tai, University of South Florida

5. EMOTIONS IN LEARNING MATHEMATICS AND ITS RELATIONSHIP TO MEMORY: USING MIND BRAIN & EDUCATION PERSPECTIVES INTO CLASSROOM PRACTICE

Muhammad Syawal Amran, Universiti Kebangsaan Malaysia

6. KNOWLEDGE IS POWER: CHILDREN ASSOCIATE SOCIAL STATUS WITH INTELLECTUAL SUCCESS

Jillian Lauer, New York University

7. THE INFLUENCE OF TIME REDUCTION ON PERFORMANCE IN ANSWERING SIMULTANEOUS LINEAR EQUATIONS FOR COLLEGE STUDENTS: A BEHAVIOR AND ERP STUDY

Jing-Fong Wang, National Tsing Hua University; **Sih-Yu Huang,** National Tsing Hua University; **Wei-Jun Liao,** National Tsing Hua University; **Tzu-Hua Wang,** National Tsing Hua University

8. APPLYING PRINCIPLES OF EDUCATIONAL NEUROSCIENCE TO IMPROVING OUTCOMES OF ADULT LITERACY PROGRAMS IN AFRICA

Michael Thomas, Birkbeck, University of London; **Victoria Knowland,** Newcastle University; **Cathy Rogers, Birkbeck,** University of London

Posters

9. COGNITIVE PREDICTORS OF STEM OCCUPATIONS: GENDER MATTERS

Helen Moriah Sokolowski, Baycrest Hospital; **Ju-Chi Yu; Carina Fan,** Baycrest Hospital; **Richard Daker,** Georgetown; **Ian Lyons,** Georgetown; **Herve Abdi,** University of Texas at Dallas; **Brian Levine,** Rotman Research Institute, Baycrest Hospital

10. RELATIONS AMONG SOCIOECONOMIC STATUS, MATERNAL PERCEIVED STRESS, AND THE HOME LANGUAGE ENVIRONMENT

Emma Hart, Teachers College, Columbia University; **Sonya Troller-Renfree,** Teachers College, Columbia University; **Jessica Sperber,** Teachers College, Columbia University; **Kimberly Noble,** Teachers College, Columbia University

11. INHIBITORY CONTROL AND THE NEURAL CORRELATES OF SCIENCE AND MATHS COUNTERINTUITIVE REASONING IN PRIMARY SCHOOL CHILDREN

Lucy R. J. Palmer, Birkbeck, University of London; **Iroise Dumontheil,** Birkbeck, University of London; **Hannah R. Wilkinson,** Birkbeck, University of London; **Dilini Sumanapala,** Birkbeck, University of London; **Emily Farran,** University of Surrey; **Michael, S. C. Thomas,** Birkbeck, University of London; **Denis Mareschal,** Centre for Brain and Cognitive Development, Birkbeck, University of London and the UnLocke Team

12. THE ROLE OF ATTENTION IN SPATIAL-TEMPORAL COGNITION AND CAUSAL REASONING IN SCIENCE

Andrew Tolmie, University College London; **Tom Northrop,** University of East London; **Darja Berga,** Birkbeck, University of London

13. AUTOMATICITY AND EXECUTIVE ABILITIES IN DEVELOPMENTAL DYSLEXIA: A THEORETICAL REVIEW

Rebecca Gordon, University College London; **James Smith-Spark,** London South Bank University

14. HOW EXERCISE AFFECTS EXECUTIVE FUNCTION AND WELL-BEING IN NEURODIVERGENT COLLEGE STUDENTS

Richard Bryck, Landmark College; **Todd Miller,** Landmark College

15. POSSIBILITIES OF SCREENING DIAGNOSIS OF CHILDREN AGED 6-10 YEARS ON THE BASIS OF EEG RECORDING

Margaret Chojak, University of Marie Curie-Sklodowska; **Agnieszka Lewicka-Zelent,** University of Marie Curie-Sklodowska; **Margaret Gulip,** University of Marie Curie-Sklodowska

16.EFFECTS OF NON-INVASIVE BRAIN STIMULATION ON EARLY MEMORY CONSOLIDATION IN MATHEMATICS LEARNING

Roland H. Grabner, University of Graz; **Julia Moser,** University of Graz; **Stefan Halverscheid,** University of Göttingen; **Roi Cohen Kadosh,** University of Surrey; **Jochen A. Mosbacher,** University of Graz

17.CONTRARY TO FINDINGS FROM WESTERN CHILDREN, NON-SYMBOLIC COMPARISON PREDICTS MATH ACHIEVEMENT IN PRIMARY SCHOOL CHILDREN FROM GHANA AND COTE D'IVOIRE

Stephanie Bugden, University of Winnipeg; **Daniel Ansari,** Western University; **Guilherme Lichand,** University of Zurich; **Sharon Wolf,** University of Pennsylvania

18. SHARING CUPCAKES ON A NUMBER LINE: INSTRUCTIONAL MODELS AND THEIR PERCEPTUAL SIMILARITY TO PARTITIONED OBJECTS

Helena P. Osana, Concordia University; **Rebecca MacCaul,** Concordia University; **Pooja G. Sidney,** University of Kentucky

19. SPECIAL EDUCATION PRE-SERVICE TEACHERS PERCEPTIONS OF A PROGRAM BASED ON NEUROSCIENCE MOTIFS. A QUALITATIVE INVESTIGATION

Efrat Luzzatto, Levinsky College of Education; **Maya Shalom,** Beit-Berl College; **Alina.S Rusu,** University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca

20. THE RELATIONSHIPS BETWEEN NEUROMYTH AND CRITICAL THINKING IN ELEMENTARY AND SECONDARY PRESERVICE TEACHERS

Kuan-Hua Chen, Fu Jen Catholic University; **Yuchun Chen,** Fu Jen Catholic University

21. BREAKING THE SYMBOL BARRIER IN MATHEMATICS: AN APPLICATION OF CONCRETENESS FADING IN EDUCATIONAL TECHNOLOGY DESIGN

Bryan Matlen, WestEd; **Daniel Murphy,** WestEd; **Randy Weiner,** BrainQuake; **Keith Devlin,** BrainQuake; **Howard Everson,** City University of New York

22. IDENTIFYING NEEDS IN THE MATH CLASSROOM: UNDERSTANDING THE EFFECTS OF ADVERSE CHILDHOOD EVENTS

Kathryn deVries, Temple University; **Laura Young,** Temple University; **Julie Booth,** Temple University

23. WHAT MAKES ONLINE TEACHING SPATIAL? EXAMINING THE CONNECTIONS BETWEEN K-12 TEACHERS' SPATIAL SKILLS, AFFECT, AND THEIR USE OF SPATIAL PEDAGOGY DURING REMOTE INSTRUCTION

Kelsey Rocha, University of California, Riverside; **Kinnari Atit,** University of California, Riverside; **Catherine Lussier,** University of California, Riverside

24. LEARNING MATH EN FRANÇAIS? THE IMPORTANCE OF DOMAIN-SPECIFIC VOCABULARY

Taeko Bourque, Carleton University; **Jo-Anne LeFevre,** Carleton University; **Heather Douglas,** Carleton University; **Sheri-Lynn Skwarchuk,** University of Winnipeg; **Chang Xu,** Carleton University; **Erin A. Maloney,** University of Ottawa; **Judith Wylie,** School of Psychology, Queen's University Belfast; **Victoria Simms,** School of Psychology, Ulster University; **Helena P. Osana,** Department of Education, Concordia University

25. MEASURING THE MINDSET OF 4-YEAR-OLDS: DESIGN AND VALIDATION OF A TOOL ADAPTED TO EARLY CHILDHOOD

Émilie Ouimet, Université du Québec à Montréal; **Lorie-Marlène Brault-Foisy,** Université du Québec à Montréal; **Blanchette-Sarrasin Jérémie,** Université du Québec à Montréal

26. LINKING UNDERGRADUATE BIOLOGY STUDENTS' MODEL-BASED REASONING AND ASSOCIATED NEURAL ACTIVITY TO ERROR DETECTION AND INHIBITORY CONTROL

Mei-Grace Behrendt, University of Nebraska-Lincoln; **McKenna Elliot,** University of Nebraska-Lincoln; **Marc Maddigan,** University of Nebraska-Lincoln; **Joseph Dauer,** University of Nebraska-Lincoln; **Carrie Clark,** University of Nebraska-Lincoln

27. WHAT VARIABLES INFLUENCE THE MOBILIZATION OF INHIBITION IN THE CONTEXT OF ELEMENTARY SCIENCE LEARNING?

Élisabeth Bélanger, Université du Québec à Montréal (UQAM); **Lorie-Marlène Brault Foisy,** Université du Québec à Montréal (UQAM); **Steve Masson,** Université du Québec à Montréal (UQAM); **Patrice Potvin,** Université du Québec à Montréal (UQAM); **Geneviève Allaire-Duquette,** Université de Sherbrooke

28. DO BODY ANALOGIES MAKE SPATIAL CONCEPTS EASIER?

Jacob Feiler, University of Alabama; **Jason Scofield,** University of Alabama

29. CONSIDERATIONS FOR MEASURING TEACHER LEARNING FROM PROFESSIONAL DEVELOPMENT: LESSONS LEARNED FROM A PILOT STUDY

Zachary Savelson, Carleton University; **Rosemary O'Connor,** University of Oxford, Wolfson College; **Steph Gunning,** Carleton University; **Sylvia Gattas,** University of Oxford, Wolfson College; **Rebecca Merkley,** Carleton University; **Gaia Scerif,** University of Oxford, Wolfson College; **Zachary Hawes,** Assistant Professor, Department of Applied Psychology & Human Development, Ontario Institute for Studies in Education/University of Toronto; **Stephen Howard,** Associate Professor, Educational Psychology, School of Education, University of Wollongong

30. MEASUREMENT OF ORDINAL SKILLS FOR STUDENTS IN GRADE 3

Zasia Hossain, Carleton University; **Chang Xu,** Carleton University; **Rebecca Merkley,** Carleton University; **Jo-Anne LeFevre,** Carleton University; **Sabrina Di Lonardo Burr,** The University of British Columbia; **Victoria Simms,** University of Ulster Helen P. Osana, Department of Education, Concordia University; **Judith Wylie,** School of Psychology, Queen's University Belfast; **Sheri-Lynn Skwarchuk,** Faculty of Education, The University of Winnipeg

31. ENACTIVE BRAIN THEORY AND EDUCATION

Kazuhisa Niki, Keio University; **Makoto Yururi,** Showa Women's University; **Juko Ando,** Keio University

Posters

32. PERSONALIZED BRAIN STIMULATION FOR EFFECTIVE NEUROINTERVENTION ACROSS PARTICIPANTS

Nienke van Bueren, Radboud University Nijmegen; **Thomas Reed,** University of Oxford; **Vu Nguyen,** University of Oxford; **James Sheffield,** University of Oxford; **Sanne van der Ven,** Radboud University Nijmegen; **Michael Osborne,** University of Oxford; **Evelyn Kroesbergen,** Behavioural Science Institute, Radboud University Nijmegen; **Roi Cohen Kadosh, Experimental Psychology,** University of Oxford

33. HOW CAN METACOGNITIVE SKILLS BE SUPPORTED IN ELEMENTARY SCHOOL CHILDREN? EVIDENCE FROM A META-ANALYSIS

Janina Eberhart, University of Tuebingen; **Franziska Schäfer,** Friedrich Schiller University Jena; **Donna Bryce,** University of Tuebingen

34. EVALUATING A RELATIONAL REASONING INTERVENTION FOR GRAPH COMPREHENSION IN MIDDLE SCHOOL

Elena Leib, University of California, Berkeley; **Hana Massab,** University of California, Berkeley; **Royalle Hurney,** University of California, Berkeley; **Michelle Wilkerson,** University of California, Berkeley; **Silvia Bunge,** University of California, Berkeley

35.CONTRIBUTIONS OF DISCRETE AND CONTINUOUS NONSYMBOLIC PROPORTIONAL REASONING TO SYMBOLIC MAGNITUDE FRACTION COMPARISON SKILLS

Roberto A. Abreu-Mendoza, Rutgers University; **Miriam Rosenberg-Lee,** Rutgers University

36.SPATIAL SKILLS AND NUMBER LINE ESTIMATION SKILLS IN LOW MATH ACHIEVING CHILDREN

Lexi Sylverne, Temple University; **Elizabeth Gunderson,** Temple University

37. DO MOM AND DAD BOTH TALK ABOUT SCHOOL? LONGITUDINAL RELATIONS BETWEEN PARENT INVOLVEMENT EQUALITY AND CHILDREN'S ACADEMIC ACHIEVEMENT

Emily D'Antonio, Temple University; **Elizabeth Gunderson,** Temple University

38. WHY TEACHERS MIGHT CHOOSE A NEUROMYTH: THE RELATIONSHIPS AMONG BELIEFS ABOUT LEARNING STYLES, EDUCATIONAL PRIORITIES, AND INSTRUCTIONAL DECISIONS

Christine Bresnahan, American University; **Emily Grossnickle Peterson,** American University; **Courtney Hattan,** Illinois State University

39. TEACHERS' USE OF CLASSROOM ACTIVITIES THAT PROMOTE SPATIAL THINKING: AN INVESTIGATION INTO PREDICTORS OF USE AND CONTENT OF SPATIAL ACTIVITIES

Jazelle Pilato, American University; **Emily Peterson,** American University; **Alida Anderson,** American University

40. THE IMPACT OF REWARD-BASED FEEDBACK ON PERSISTENCE BEHAVIOR IN AN EDUCATIONAL GAME

Kirk Vanacore, Worcester Polytechnic University; **Allison Liu,** Worcester Polytechnic University; **Adam Sales,** Worcester Polytechnic University; **Erin Ottmar,** Worcester Polytechnic University

41. EVIDENCE OF INHIBITORY CONTROL IN EEG PATTERNS OF CHILDREN OVERCOMING THE "MOVING THINGS ARE ALIVE" MISCONCEPTION

Jérémie Blanchette Sarrasin, Université du Québec à Montréal; **Lorie-Marlène Brault Foisy,** Université du Québec à Montréal; **Yannick Skelling-Desmeules,** Université du Québec à Montréal; **Patrice Potvin,** Université du Québec à Montréal; **Steve Masson,** Université du Québec à Montréal; **Patrick Charland,** Université du Québec à Montréal

42. APPROACHING THE BRIDGE: MBE IDENTITY DEVELOPMENT IN THE TEACHER EDUCATOR

Pamela Clinkenbeard, University of Wisconsin-Whitewater

43. MATHEMATICAL INTERVENTION WITH PARENTS OF CHILDREN WITH DEVELOPMENTAL LANGUAGE DISORDERS: IMPACT ON PARENTS' MATHEMATICAL PRACTICES AND CHILDREN'S EARLY MATHEMATICAL SKILLS (MULTIPLE CASE STUDY)

Aurélie Marcelot, Université Claude Bernard Lyon 1; **Emilie Corsani;** Anne Lafay, Université Savoie Mont Blanc

44. MULTILEVEL UNIT COORDINATION STRATEGIES USED BY CHILDREN IN THE FIRST- AND SECOND-GRADE

Anne Lafay, Université Savoie Mont Blanc; **Helena Osana,** Concordia University; **Bianca Doheney,** Concordia University; **Mélanie Barilaro,** Concordia University; **Isabelle Atkins,** Université du Québec à Montréal; **Andie Storozuk,** University of Ottawa; **Erin A. Maloney,** Department of Psychology; University of Ottawa

45. AGENTS OF CHANGE: A NEUROPEDAGOGICAL TRAINING PROGRAM FOR TEACHER EDUCATORS

Ayelet Katzoff, Levinsky College of Education; **Etty Grobgeld,** Achva Academic College; **Inna Shvarts-Serebro,** Bar-Ilan University; **Orit Elgavi,** Herzog Educational College; **Efrat Luzzatto,** Levinsky College of Education; **Maya Shalom, B**eit Berl College Gal Ben-Yehudah, MOFET Institute; **Israel Isaac Friedman,** Department of Educational Administration, Achva Academic College

46. HOW TO MEASURE AND IMPROVE ATTENTIONAL ENGAGEMENT IN VIDEO-BASED LEARNING?

Lucas C Parra, City College of New York; **Maximilian Nentwich,** City College of New York; **Jens Madsen,** City College of New York

Posters

Friday, July 22

47. DOES MATH MATTER? EXPLORING THE NEURO-BEHAVIORAL CORRELATES OF PHONOLOGICAL PROCESSING IN READERS WITH DYSLEXIA, WITH AND WITHOUT COMORBID MATH DISORDER

Rebecca A. Marks, Massachusetts Institute of Technology; **Courtney Pollack,** Harvard University**; Anila D'Mello,** Massachusetts Institute of Technology; **John D. E. Gabrieli,** Massachusetts Institute of Technology; **Joanna Christodoulou,** MGH Institute of Health Professions

48. SOCIOECONOMIC STATUS MODERATES STUDENTS' PROCESSING ACROSS VERBAL AND VISUAL MODALITIES IN SCIENCE EDUCATION

Jazelle Pilato, American University; **Emily Peterson,** American University

49. FOUNDATIONS OF EARLY NUMERACY AND EXECUTIVE FUNCTIONS

Sylvia Gattas, University of Oxford, Wolfson College; **Alex Fraser,** University of Oxford, Somerville College; **Mihaela Duta,** University of Oxford; **Gaia Scerif,** University of Oxford

51. OVERLAPPING SEMANTIC REPRESENTATIONS OF SIGN AND SPEECH IN NOVICE SIGN LANGUAGE LEARNERS

Megan Hillis, Dartmouth College; **Brianna Aubrey,** Dartmouth College; **Julien Blanchet,** Dartmouth College; **Qijia Shao,** Dartmouth College; **Xia Zhou,** Dartmouth College; **Devin Balkcom,** Dartmouth College; **David Kraemer,** Psychological and Brain Sciences and Education departments, Dartmouth College

52. MORNINGNESS-EVENINGNESS IS ASSOCIATED WITH LEARNING-RELATED PSYCHOLOGICAL CHARACTERISTICS IN UNDERGRADUATE STUDENTS

Yng Miin Loke, Duke-NUS Medical School; **Clin Kam Yuue Lai,** Duke-NUS Medical School and National University of Singapore; **Sing Chen Yeo,** Duke-NUS Medical School; **Patricia Chen,** National University of Singapore; **Timothy J. Strauman,** Duke University; **Robert K. Kamei,** Yong Loo Lin School of Medicine, National University of Singapore and Duke University School of Medicine; **Joshua J. Gooley,** Neuroscience and Behavioural Disorders (NBD), Duke-NUS Medical School

53. PROMOTING COGNITIVE FLEXIBILITY BY VARYING COGNITIVE LOAD? AN EMPIRICAL STUDY ON ARITHMETIC REASONING

Hippolyte Gros, CY Cergy Paris University; **Evelyne Clément,** CY Cergy Paris University; **Sébastien Puma,** CY Cergy Paris University

54. PHONOLOGY DISSOCIATES PHENOTYPES OF DYSLEXIA

Sarah M. Inkelis, University of California, San Francisco; **Christa L. Watson Pereira,** University of California. San Francisco; **Abigail Licata,** University of California. San Francisco; **Rian Bogley,** University of California, San Francisco; **Mieke Voges,** University of California, San Francisco; **Maria Luisa Mandelli,** University of California, San Francisco; **Eduardo Caverzasi** and **Maria Luisa Gorno Tempini,** Neurology / UCSF Dyslexia Center**,** University of California, San Francisco

55. BRAIN BASES OF MORPHOLOGICAL PROCESSING DIFFER BETWEEN DYSLEXIA AND TYPICAL DEVELOPMENT

Rachel Eggleston, University of Michigan; **Rebecca Marks,** Massachusetts Institute of Technology; **Xin Sun,** University of Michigan; **Kehui Zhang,** University of Michigan; **Chi-Lin Yu,** University of Michigan; **Nia Nickerson,** University of Michigan; **Xiaosu Hu,** University of Michigan; **Ioulia Kovelman** (Developmental Psychology), University of Michigan

56. A REMOTE RANDOMIZED CONTROLLED TRIAL AUDIOBOOK INTERVENTION

Halie Olson and **Ola Ozernov-Palchik,** Massachusetts Institute of Technology; **Xochitl Arechiga,** Massachusetts Institute of Technology; **Kimberly Wang,** Massachusetts Institute of Technology; **Jeff Dieffenbach,** Massachusetts Institute of Technology; **John Gabrieli,** Massachusetts Institute of Technology

57. COSTS AND BENEFITS OF TELLING CHILDREN THE QUANTITATIVE MEANING OF MANIPULATIVES

Emmanuelle Adrien, Concordia University; **Helena P. Osana,** Concordia University; **David H. Uttal,** Northwestern University

58. MEDIATING EFFECT OF PUBERTAL STAGES ON THE FAMILY ENVIRONMENT AND NEURODEVELOPMENT: HOW THE CONCEPTUAL REPLICATION AND MULTIVERSE ANALYSIS OF AN ABCD STUDY CAN BETTER INFORM ADOLESCENT EDUCATION POLICY

Michael Demidenko, University of Michigan; **Dominic Kelly,** University of Michigan; **Felicia Hardy,** University of Michigan; **Ka Ip,** Yale University; **Sujin Lee,** University of Michigan; **Hannah Becker,** University of Michigan; **Sunghyun Hong** (Psychology, University of Michigan, Michigan, United States)**; Sandra Thijssen,** (Behavioural Science Institute, Radboud University, Nijmegen, Psychology, University of Minnesota; **Monica Luciana,** Psychology, University of Minnesota and **Daniel P. Keating** Psychology, University of Michigan, Institute of Social Research, University of Michigan

59. COGNITION-BASED TEACHING FOR PRE-SERVICE TEACHERS

Chris Mattatall, University of Lethbride

60. SECONDARY TEACHERS' NEURAL ACTIVITY WHEN GRADING STUDENT WORK DIFFERS ACCORDING TO THE SOCIAL-COGNITIVE COMPLEXITY OF THEIR PEDAGOGICAL ORIENTATION

Christina Kundrak, University of Southern California; **Xiao-Fei Yang,** University of Southern California; **Mary Helen Immordino-Yang,** University of Southern California

61. BRINGING GENDER BALANCE TO COMPUTER SCIENCE EDUCATION

Meili Xu, Johns Hopkins University; **Christine Eccles,** Johns Hopkins University

62. EXPLORING FUNCTIONAL BRAIN NETWORK MODULARITY IN EDUCATIONAL CONTEXTS

Kelly Michaelis, Georgetown; **Adam Weinberger,** University of Pennsylvania; **Robert Cortes,** Georgetown; **Richard Betzel,** Indiana University; **Adam Green,** Georgetown

63. FINE MOTOR SKILLS DURING EARLY CHILDHOOD PREDICT VISUOSPATIAL DEDUCTIVE REASONING IN ADOLESCENCE

Robert Cortes, Georgetown University; **Adam Green,** Georgetown University; **Rachel Barr,** Georgetown University; **Rebecca Ryan,** Georgetown University

64. THE SOCIAL-COGNITIVE COMPLEXITY OF TEACHERS' PEDAGOGICAL ORIENTATIONS INDIRECTLY LINKS THEIR INTERPRETATIONS OF CLASSROOM HAPPENINGS WITH THEIR TEACHING PRACTICES

Emily Candaux, Teachers College, Columbia University; **Christina Kundrak,** University of Southern California; **Mary Helen Immordino-Yang,** University of Southern California; **Doug Knecht,** Banks Street College of Education; **Jeffrey Garrett,** Partnership for Los Angeles Schools

Posters

65. A TOOLKIT IS NOT ENOUGH: QUALITY OF TEACHERS' PRACTICE IS PREDICTED BY TEACHERS' CONCEPTUALIZATIONS OF STUDENT DEVELOPMENT AND AGENCY

Emily Gonzalez, USC Rossier School of Education; **Christina Kundrak,** USC Rossier School of Education; **Mary Helen Immordino-Yang,** University of Southern California

66. A SCOPING REVIEW OF THE LITERATURE ON ADULT LEARNING PROCESSES IN DISTANCE EDUCATION

Anne Fensie, University of Maine; **Aubrey Rogowski,** Utah State University; **Aoife O'Mahony,** Cardiff University; **Parm Gill,** University of British Columbia; **Karen Bellnier,** University of Rhode Island; **Linda Wiley,** Baker University; **Parm Gill,** Centre for Teaching, Learning and Technology, University of British Columbia; **Karen Bellnier,** Office for the Advancement of Teaching and Learning, University of Rhode Island; **Linda Wiley;** Instructional Design and Performance Technology, Baker University; **Rebecca Clark-Stallkamp,** Instructional Design and Technology, Virginia Tech; **Sharon Stidham,** Instructional Design and Technology, Virginia Tech**; Teri St. Pierre,** Mathematics, University of Maine; **Megan Alicea,** College of Applied and Technical Studies, Kent State University; **Melissa Jones,** Instructional Systems & Learning Technologies, Florida State University; **Katrina Wehr,** Office of Digital Learning, Penn State University; **J. Meryl Krieger, Arts and Sciences** Online Learning, University of Pennsylvania; **Lauren Stalford,** Instructional Design, Purdue University

67. UPDATING LITERACY MODELS FOR BILINGUAL CHILDREN: MORPHOLOGICAL AWARENESS CROSS-LINGUISTICALLY INTERACTS WITH READING IN SPANISH AND ENGLISH

Eva McAlister López, University of Michigan; **Rebecca Marks,** University of Michigan; **Ioulia Kovelman, University of Michigan**

68. OSCILLATORY EEG PATTERNS OF MULTIPLICATION AND SUBTRACTION PROBLEM SOLVING IN FOURTH GRADERS

Stephan E. Vogel, University of Graz; **Clemens Brunner,** University of Graz; **Nikolaus A. Koren,** University of Graz; **Judith Scheucher,** University of Graz; **Jochen A. Mosbacher,** University of Graz; **Bert De Smedt,** KU Leuven Roland H. Grabner, Educational Neuroscience, Institute of Psychology, University of Graz

69. THE PERFORMANCE OF FIELD-INDEPENDENCE AND FIELD-DEPENDENCE STUDENTS IN ANSWERING MATHEMATICS ALGEBRA QUESTIONS: A SIGNAL DETECTION THEORY PERSPECTIVE

Jing-Fong Wang, National Tsing Hua University; Yi-Ting Chen, National Tsing Hua University; **Pei-Chu Peng,** National Tsing Hua University; **Tzu-Hua Wang,** National Tsing Hua University

70. EXPLORING THE LONGITUDINAL AND CROSS-SECTIONAL RELATIONSHIPS BETWEEN WHITE MATTER AND READING SKILL

Ethan Roy, Stanford University; **Adam Richie-Halford,** Stanford University; **John Kruper,** University of Washington; **Manjari Narayan,** Stanford University; **David Bloom,** University of Washington; **Timothy Brown,** University of California; **Terry L. Jernigan,** University of California, Center for Human Development; **Bruce D. McCandliss,** Stanford University, Graduate School of Education; **Ariel Rokem,** Department of Psychology and eScience Institute, University of Washington; **Jason D. Yeatman,** Stanford University, Graduate School of Education

71. EFFECTS OF EMOTIONAL VALENCE ON THE LEARNING OF CONCRETE AND ABSTRACT WORDS IN A FOREIGN LANGUAGE

Roberto A. Ferreira, Universidad Católica del Maule; **Cristina Rodríguez,** Universidad Católica del Maule

72. THE ROLE OF CONTINUOUS MAGNITUDES, INHIBITORY CONTROL, AND CARDINALITY KNOWLEDGE IN DOT COMPARISON TASK

Cristina Rodríguez, Universidad Católica del Maule; **Roberto A. Ferreira,** Universidad Católica del Maule

73. GENDER SIMILARITIES AND DIFFERENCES IN GENERAL INTELLIGENCE: A META-ANALYTIC REVIEW

Jillian Lauer, New York University; **Andrei Cimpian,** New York University

74. WORKING MEMORY PERFORMANCE IN KINDERGARTEN PREDICTS GIRLS' (BUT NOT BOYS') MATHEMATICS ANXIETY IN SECOND GRADE

Bárbara Guzmán, Universidad Católica de la Santísima Concepción; **María Cristina Rodríguez,** Universidad Católica del Maule; **Roberto A. Ferreira,** Universidad Católica del Maule

75. TAKEN BY SURPRISE? THE ROLE OF SURPRISE IN LEARNING FROM PREDICTIONS

Dietsje Jolles, Leiden University; **Vibeke Nielsen,** Leiden University; **Linda Van Leijenhorst,** Leiden University; **Elena Galeano-Keiner,** DIPF | Leibniz Institute for Research and Information in Education; **Garvin Brod,** DIPF | Leibniz Institute for Research and Information in Education

76. SUPPORTING BIODIVERSITY EDUCATION THROUGH METAPHORS AND ANALOGIES

Laura Leon Perez, University of Geneva; Catherine Audrin, University of Teacher Education Lausanne; **Emmanuel Sander,** University of Geneva

77. CHALLENGES TO MEASURING EARLY INTERESTS IN SCIENCE

Jihye Bae, Vanderbilt University, Peabody College; **Margaret Shavlik,** Vanderbilt University, Peabody College; **Amy Booth,** Vanderbilt University, Peabody College

78. TRACKING NEURAL REPRESENTATIONS WHEN CONNECTING NEW INFORMATION TO STRUCTURED PRIOR KNOWLEDGE

Jiawen Huang, Columbia University; **Hannah Tarder-Stoll,** Columbia University; **Christopher Baldassano,** Columbia University

79. THE BENEFITS OF RECODING FOR FOSTERING ADAPTIVE EXPERTISE

Katarina Gvozdic, University of Geneva; **Emmanuel Sander,** University of Geneva

80. WHAT MAKES MENTAL MODELING DIFFICULT? NORMATIVE DATA FOR THE MULTIDIMENSIONAL RELATIONAL REASONING TASK

Danny Holzman, Georgetown University; **Robert Cortes,** Georgetown University; **Adam Weinberger,** Georgetown University / University of Pennsylvania; **Griffin Colaizzi,** Georgetown University; **Grace Porter,** Georgetown University; **Emily Dyke,** Georgetown University **Holly Keaton,** Department of Psychology, Georgetown University; **Dakota Walker,** Department of Psychology, Georgetown University; **Adam Green,** Department of Psychology and Interdisciplinary Program in Neuroscience, Georgetown University

81. IRT MODELLING OF GO/NO-GO TASK PERFORMANCE: CONSIDERATIONS FOR COMPUTERIZED COGNITIVE GAMES

Sarah Jo Torgrimson, University of California Los Angeles; **Minjeong Jeon,** University of California Los Angeles; **Elif Isbell,** University of California Merced; **Jennie K. Grammer,** University of Virginia

82. CURIOUS KIDS: HOW CURIOSITY AND PRIOR KNOWLEDGE ENHANCE MEMORY AND LEARNING IN YOUNG CHILDHOOD

Naoya Tani, Temple University; Ingrid Olson, Temple University; **Nora Newcombe,** Temple University

83. RELATING NEURAL MECHANISMS FOR LEARNING TO INSTRUCTIONAL EVENTS IN ONLINE LEARNING ENVIRONMENTS

Jeonghyun (Jonna) Lee, Georgia Institute of Technology; **Matt Bezdek,** Washington University; **Meryem Soylu,** Georgia Institute of Technology; **Farahnaz Soleimani,** Georgia Institute of Technology; **Tiffany Nguyen,** Georgia Institute of Technology; **Jenna Joshi,** Georgia Institute of Technology; **Ritika Chanda,** School of Psychology, Georgia Institute of Technology; **Eric Schumacher,** School of Psychology, Georgia Institute of Technology; **Stephen Harmon,** Center for 21st Century Universities (C21U), Georgia Institute of Technology

84. RESPONSE TIME MEASURES THE LONGITUDINAL DEVELOPMENT OF HIERARCHICAL VISUAL WORD RECOGNITION

Lindsey Hasak, Stanford University; **Suanna Moron,** Stanford University; **Madison Bunderson,** Stanford University; **Fang Wang,** Stanford University; **Bruce McCandliss,** Stanford University

Posters

85. EARLY SIGN-SPEECH BILINGUALISM HELPS CHILDREN LEARN READING

Bradley E. White, Gallaudet University; **Cryss Padilla,** Gallaudet University; **Kristina McKinnie,** Gallaudet University; **Claudia Smistek,** Gallaudet University; **Laura-Ann Petitto,** Gallaudet University

86. MEANING TO MULTIPLY: ELECTROPHYSIOLOGICAL EVIDENCE OF SEMANTIC MEMORY ACCESS AND ORGANIZATION FOR MULTIPLICATION IN CHILDREN

Amandine E Grenier, University of Texas at San Antonio; **Nicole Y. Y. Wicha,** University of Texas at San Antonio

87. RELATIONS BETWEEN MINORITY STATUS STRESS, THE TESTING EFFECT, THE LATE POSITIVE POTENTIAL, AND THE FEEDBACK RELATED NEGATIVITY

Salvador R. Vazquez, University of California, Los Angeles; **Jaquelin Aquino,** University of California, Los Angeles; **Maddie Ward,** University of California, Los Angeles; **Joel P. Diaz,** University of California, Los Angeles; **Jennie K. Grammer,** University of California, Los Angeles/University of Virginia

88. DIFFERENCES IN STUDYING: QUANTITATIVE COURSES, MATH ANXIETY, AND STUDY STRATEGIES

Amira FA Ibrahim, CSU Channel Islands; **Sarah McKellar,** University of Pittsburgh; **Priti Shah,** University of Michigan

89. CAPTURING THE CAUSAL IMPACT OF THE WORDS TEACHERS TEACH: LEARNING AND RETENTION DYNAMICS IN A NATURALISTIC CLASSROOM TRAINING STUDY

Radhika Gosavi, Stanford University & Synapse School; **Elizabeth Toomarian,** Stanford University & Synapse School; **Suanna Moron,** Stanford University; **Ethan Roy,** Stanford University; **Lindsey Hasak,** Stanford University; **Bruce McCandliss,** Stanford University

90. AN INSTRUMENT FOR MEASURING ADOLESCENTS' PERCEIVED VALUE OF CONSTRUCTIVE INTERNAL REFLECTION FOR SOCIAL-EMOTIONAL GROWTH

Erik Jahner, University of Southern California; **Christina Kundrack,** University of Southern California; **Rebecca Gotlieb,** University of California Los Angeles; **Rodrigo Miranda,** University of Southern California; **Mary Helen Immordino-Yang,** University of Southern California

91. THE BRAINWAVE LEARNING CENTER: EXPLORATIONS AND LESSONS LEARNED FROM A RESEARCH-PRACTICE PARTNERSHIP APPROACH TO EDUCATIONAL NEUROSCIENCE

Elizabeth Toomarian, Stanford University & Synapse School; **Radhika Gosavi,** Stanford University & Synapse School; **Lindsey Hasak,** Stanford University; **Bruce McCandliss,** Stanford University

92. MEASURING PROGRESS IN EDUCATIONAL NEUROSCIENCE THROUGH A SYSTEMATIC REVIEW AND BIBLIOMETRIC ANALYSES: PRELIMINARY RESULTS

Astrid Schmied, Nanyang Technological University

EARLI/SIG 22 Lightning Talks

Saturday, July 23
3:45–4:45 pm: Opus

Relating Neural Mechanisms for Learning to Instructional Events in Online Learning Environments

Speakers: **Meryem Yimaz Soylu,** Georgia Institute of Technology

Effects of Non-Invasive Brain Stimulation on Early Memory Consolidation in Mathematics Learning

Speakers: **Roland Grabner,** University of Graz

Secondary Teachers' Neural Activity when Grading Student Work Differs According to the Social-Cognitive Complexity of their Pedagogical Orientation

Speakers: **Christina Kundrack,** USC Rossier School of Education

Exploring the Longitudinal and Cross-Sectional Relationships Between White Matter and Reading Skill

Speakers: **Bruce McCandliss,** Stanford University

Panel Discussions

Saturday, July 23, 1:00–2:00 pm: Concerto

Impact of Digital Tools on Education Research

Panel Discussants: Jessica Younger, Blue Jay Advising LLC; **Elena Canadas**, Akili Interactive Labs; **Ido Davidesco**, University of Connecticut; **Anna Levy**, Fordham University

The unprecedented explosion of digital innovation in the wake of the COVID-19 pandemic has ushered in a new era for developmental research. The proliferation of technology has brought both new opportunities and challenges to education research. In this symposium, we will discuss how these advancements have been embraced by researchers across different contexts. After an overview of remote research has evolved during the pandemic, we will have four speakers share how their research has been impacted by digital tools. First, Dr. Courtney Gallen will discuss how the technologies that enabled us to work remotely allowed the Education Division at the UCSF Neuroscape Center to conduct an in-school training intervention from home. From facilitating data collection sessions over Zoom and using Google Classroom to administer cognitive tasks, Neuroscape leveraged the new normal to conduct education research that reached broader populations and increased flexibility for students, educators, and the Neuroscape team. Next, Dr. Elena Canadas will discuss the use of mobile tools to target attentional control networks of the brain in Attention Deficit Hyperactivity Disorders. The recent advancements of digital therapeutics represents a potential new method for helping students improve their cognitive abilities and academic performance. Dr. Fumiko Hoeft will share how the development of a digital screening tool for reading disorder risk represents a shift in the educational landscape. By creating a fully-automated digital screening tool, schools can have a low-cost solution for detecting potential reading difficulties earlier, leading to improved educational outcomes for students in need. Finally, Dr. Ido Davidesco will talk about shifting a neuroscience high school curriculum to an online learning environment, where students designed brain-inspired investigations and collected data from peers and family members with virtual guidance from scientists. Despite some challenges, this effort generated a fully remote and more scalable curriculum and insights on facilitating virtual partnerships between scientists, teachers, and students. While these new tools have led to advancements, they are not without their challenges. All speakers will discuss the surprises, both good and bad, they encountered during their research and the lessons learned along the way. They will also discuss their vision for the future of educational research, both the opportunities and areas for improvement that the rapid innovation in technology brings, including how to develop technological solutions that ensure equitable access and representation of diverse populations in research. This symposium will be chaired by Dr. Jessica Younger, who will draw on her background in educational research in both academic and industry settings to facilitate discussion on how researchers and educators can incorporate digital tools in their work.

Saturday, July 23, 1:00–2:00 pm: Concerto

Applying the Science of Learning to Teacher Preparation

Panel Discussants: Jim Heal, Deans for Impact

In 2019, the Learning by Scientific Design Network began the vital - albeit challenging - work of redesigning how teachers are prepared. This effort, grounded in principles of learning science and taking place in 10 educator-preparation programs across the country, involves more than 70 faculty working to change the arc of experiences that 2,100 teacher-candidates receive every year as they prepare to become teachers. This symposium will offer on-the-ground insights into the network from those directly involved, and will examine what it looks like to translate principles of learning science into practice in the context of educator preparation. Participants will hear from Hilary Dack - Associate Professor and head of the middle grades program at the department of Middle, Secondary, and K-12 Education, University of North Carolina at Charlotte. Dack was a founding Learning by Scientific Design Network member who redesigned her teacher preparation program to place learning science principles at the core. We will also be joined by Rebekah Berlin - Senior Program Director at Deans

for Impact and founding Director of the Learning By Scientific Design Network - who designed a first-of-its-kind learning science assessment as a benchmark for this work and facilitated the change management processes required to infuse these principles into Universities' practices. In sharing the findings and reflections, we begin with a fundamental question, "Was it successful?" before exploring lessons learned and broader implications for teacher preparation. Specific questions for consideration will include:
* Which learning science principles and actions have high-leverage when it comes to changing educator preparation and teaching practice for the better?
* How might teachers and teacher-educators go about infusing such principles into their day-to-day approaches to instruction? * What does it take to challenge pervasive edu-myths and 'folk pedagogies'?
* What are the implications of applying a learning science lens when it comes to teaching for equity and justice?

Saturday, July 23, 1:00–2:00 pm: Tchaikowsky

Science Writing for a Wide Audience

Panel Discussants: Annie Brookman-Byrne, Jacobs Foundation; **Gemma Wirz,** Jacobs Foundation

Communicating research to parents, teachers, policymakers, and the general public is an important part of the MBE endeavour. But it can be difficult to get right. In this session, meet Gemma Wirz, Editor-in-Chief of BOLD, and Annie Brookman-Byrne, Deputy Editor of BOLD, who will share their writing tips and advice. They will discuss what makes an engaging and informative piece of writing, how to communicate nuance, and how to bring storytelling into science writing. They will also share insight into the behind the scenes process of writing for BOLD and other outlets, including how to pitch your idea.

2022 IMBES Awards

IMBES Early Career Award

This award is designed to recognize early career scholars who have made significant, original research contributions to the field of Mind, Brain, and Education.

2022 Recipients

Dr. Ido Davidesco
University of Connecticut, USA

Dr. Allyson Mackey
University of Pennsylvania, USA

IMBES Translation Award

This award is designed to recognize senior scholars who have made significant progress towards strengthening the links between research and practice in Mind, Brain, and Education. Nominees' work can target translation of research into practice in traditional/formal or in non-traditional/informal contexts. (For example, the work can target formal learning environments such as schools and colleges, informal learning environments such as museums, community centers and rehabilitation programs, or science media intended for the broader public.)

2022 Recipients

Dr. David Uttal
Northwestern University, USA

Exemplifying the Mission of IMBES Award

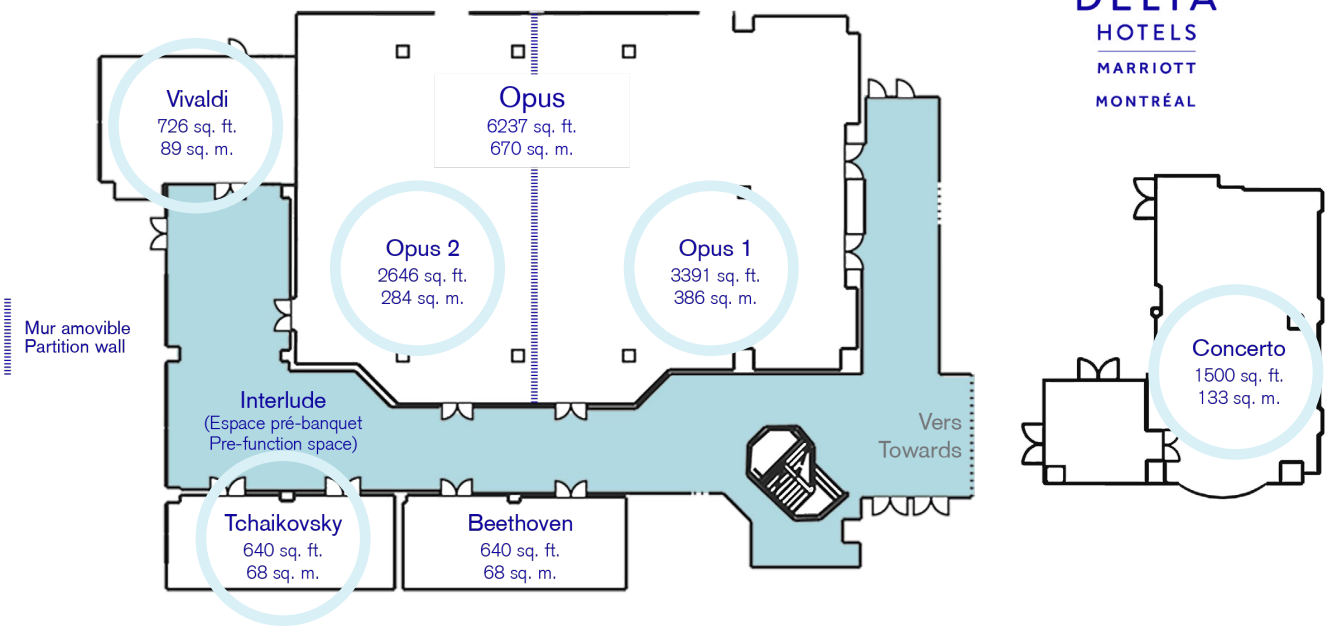
Recognizes Pre K-12 educators, institutions or programs demonstrating success in establishing, building and supporting infrastructure that enhances collaboration between themselves and MBE researchers for the purpose of improving educational knowledge and practice. We seek to honor the creators of infrastructure that models how productive collaboration can unfold in the field of Mind, Brain and Education.

2022 Recipients

Brainwave Learning Center

Floorplan & Sponsors

Mezzanine Floor



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